REMARKS

Claims 18 and 20-27 are pending. Claim 26 is withdrawn from further consideration. Claims 18, 20-25 and 27 are rejected. Reconsideration in light of the following remarks is requested.

Claim Rejections under 35 USC 103

The Examiner bears the initial burden of factually supporting any *prima facie* conclusion of obviousness. MPEP 2142. To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation in the references themselves or in the knowledge generally available to one of ordinary skill in the art to modify the reference. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. MPEP 2142 (citing *In re Vaeck*, 947 F.2d 488 (Fed. Cir. 1991)).

In affirming the obviousness analysis that it had set forth in *Graham v. John Deere Co. of Kansas City*, 383 U.S. 1 (1966), the Supreme Court has also stated that "[t]here is no necessary inconsistency between the idea underlying the TSM [i.e., teaching-suggestion-motivation] test and the *Graham* analysis." *KSR Int'l Co. v. Teleflex Inc.*, No. 04-1350, slip op. at 13 (2007). Thus, the Supreme Court has not invalidated the TSM test, but rather only rejected its "rigid" application. *See id.* at 11. An obviousness rejection continues to require an explicit analysis providing some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness. *See id.* at 14 (citing *In re Kahn*, 411 F.3d 977, 988 (Fed. Cir. 2006)).

Over Sigal in view of Meade and Roberts

Claims 18, 20, 24 and 27 are rejected under 35 USC 103(a) as allegedly being unpatentable over US Patent 6,319,670 to Sigal et al. in view of US Patent 5,770,369 to Meade et al. and US Patent 5,958,791 to Roberts et al.

On page 3 of the Office Action, the Examiner concedes that "Sigal et al. do not disclose . . . a detector capable of detecting the voltage associated with electron transfer moiety as recited in a) and c) of claim 18." As presented in the previous response, Sigal is directed to compositions and methods used to measure the presence of analyte by measuring electrochemiluminescence triggered by a voltage imposed on a working electrode. *See* col. 1, lines 15 – 19 and lines 48-49. In electrochemiluminescence assays, a reactive species is reduced and thus placed in an excited state. Upon relaxation, a photon is emitted and detected by a photomultiplier tube (PMT).

If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teaching of the references are not sufficient to render the claims *prima facie* obvious. MPEP 2143.01(VI) (citing *In re Ratti*, 270 F.2d 810 (CCPA 1959)). As stated above, a critical step in electrochemiluminescence assays is the detection of photons. Claim 18 recites a detector capable of detecting a voltage associated with electron transfer from an electron transfer moiety. Such detector does not detect photons, and so would change the principle of operation of the composition taught by Sigal.

Furthermore, if proposed modification or combination would render the referenced invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. MPEP 2143.01(V) (citing *In re Gordon*, 733 F.2d 900 (Fed. Cir. 1984)). The compositions and methods for conducting electrochemiluminescence binding assays of Sigal would not achieve their intended purpose if the detector of claim 18 replaced the photomultiplier tube in Sigal. Since the detector of claim 18 does not detect photons, ligand binding according to Sigal could not be detected.

The Examiner relies on Meade to provide the motivation for replacing the photon detector of Sigal with the "detector capable of detecting a voltage associated with electron transfer from said electron transfer moiety" as recited in the claims.

The Examiner suggests on page 4 of the Office Action that replacement of an optical detector with an electrical detector would have been obvious because "the methods capable of detecting an electron transfer moiety are exchangeable (see Meade *et al.*, column 25, fifth paragraph)." However, the Examiner has mischaracterized the teaching of Meade. In column 25, lines 42-47, Meade teaches that "**Electron transfer** through nucleic acid can be detected in a variety of ways. A variety of detection methods may be used including, but not limited to, optical detection . . . and electronic detection[.]" (emphasis added) According to Meade, depending on the choice of electron transfer moieties, electron transfer is detected in some cases optically and in some cases by detecting voltages.

The fact that either optical or electronic detection can be used to detect electron transfer does not mean that one of skill in the art would use the detector of claim 18 to replace the photomultiplier tube of Sigal, where emitted photons, not electron transfer, are being directly detected. In other words, the existence of at least two devices to detect **electron transfer** as taught by Meade does not lead to the conclusion that those two devices are interchangeable for detecting **photons** in the manner taught by Sigal. A voltage detector does not detect photons.

The Examiner, who must state a reason to combine the references even under *KSR* in order to establish a prima facie case of obviousness, has proffered no reason as to why one of skill in the art would use the detector of claim 18 for detecting a voltage associated with electron transfer from an electron transfer moiety in an assay where the principle of operation is the detection of **photons**. The Examiner has thus failed to establish a prima facie case of obviousness. Even assuming for the sake of argument that the Examiner has met his burden, Applicants have rebutted any prima facie case of obviousness by showing that modification of the primary reference would change the principle of its operation and further render it unsatisfactory for its intended purpose.

The Examiner concedes Sigal does not teach "an array of electrodes." *See* Office Action of January 22, 2007 and Office Action of June 29, 2006. The Examiner then contends that one of skill in the art would be motivated to modify Sigal and Meade in view of Roberts to arrive at the presently claimed invention. Applicants note that claim 18 recites "an array of **working** electrodes." The interdigitated arrays in Roberts, column 7, line 66 to column 8, line 26, as cited by the Examiner, are not working electrodes. Roberts states that "[a]dvantages of fabricating small electrodes in interdigitated array go even further by allowing redox cycling of ions back and forth between anode(s) and cathode(s)." This passage implies that the interdigitated array of Roberts comprises not working electrodes, but rather, one working electrode having multiple fingers interdigitated with one reference electrode also having multiple fingers. Furthermore, the advantages of "increasing the size of mass transport, increasing the signal-to-noise (faradaic/charging current) ratio, and decreasing ohmic signal losses" are in reference to the small scale of the electrodes, rather than to any configuration of working arrays. Thus, Sigal combined with Meade and Roberts do not teach all of the limitations of claim 18. In this further respect, the Examiner has failed to establish a prima facie case of obviousness.

Because claim 18 is not obvious over the combination of the cited references, Applicants request withdrawal of the rejection under 103(a) of claim 18 and claims 20-25 and 27 dependent therefrom.

Over Sigal in view of Meade, Roberts and Bamdad

Claim 21 is rejected under 35 USC 103(a) as allegedly being unpatentable over Sigal in view of Meade, Roberts and US Patent 5,620,850 to Bamdad et al. The Examiner claims that Bamdad teaches a self-assembling monolayer that is made by alkyl thiol functional groups.

As argued above, claim 18 is not obvious over Sigal in view of Meade and Roberts. Bamdad, directed toward derivatized surfaces for surface plasmon resonance experiments, does not cure the deficiencies of the references. Therefore, not all of the limitations of claim 21 are found in the cited references, and so a prima facie case of obviousness has not been established for claim 21. Applicants request withdrawal of the rejection.

Over Sigal in view of Meade, Roberts and Gerpheide

Claim 22 is rejected under 35 USC 103(a) as allegedly being unpatentable over Sigal in view of Meade, Roberts and US Patent 5,565,658 to Gerpheide et al. The Examiner claims that one of skill in the art would use a printed circuit board as taught by Gerpheide because "fabrication of electrodes on a printed circuit board would provide an economical and widely available way to make an array of electrodes. One having ordinary skill in the art at the time the invention was made would have a reasonable expectation of success to use a printed circuit board as a substrate to make an array of electrodes."

If proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. MPEP 2143.01(V) (citing *In re Gordon*, 733 F.2d 900 (Fed. Cir. 1984)).

Assuming for the sake of argument that Roberts teaches an array of working electrodes, Roberts teaches at column 5, lines 32-34, that its device "includes an absorbent material, having a contact portion proximate to one end for contact with and uptake of the test solution." Each of the conductors in Roberts "comprises a plurality of fingers disposed on the absorbent material." *Id.* at lines 37-38. Absorbent material means

> a porous material having a pore size of from 0.05 μm to 50 μm, preferably from 0.45 μm to 5 μm, which is susceptible to traversal by an aqueous medium in response to capillary force. Such materials may be natural polymeric materials, particularly cellulosic materials, such as fiber-containing papers, . . . [and] synthetic or modified naturally occurring polymers, such as nitrocellulose. . . . Nitrocellulose is a preferred absorbent material.

Id. at col. 12, lines 3- 15.

Gerpheide, however, teaches at column 5, lines 28-30, that "the electrode array may utilize a flexible printed circuit board, such as a flex circuit, or stampings of sheet metal or metal foil." One of skill in the art would understand that sheet metal and metal foil are not absorbent materials. Furthermore, one of skill in the art would understand that substrates used in flex circuits are preferably not absorptive. *See* Joseph Fjelstad, *Flexible Circuit Technology* 43 (3d ed.

2007) (attached as Exhibit A; "Moisture absorption is definitely not desirable for any flexible substrate. Moisture can negatively impact both the manufacturing process (by causing delamination, in process or in assembly) and the performance of the finished product (by altering the material's dielectric constant and increasing signal loss.)")

Thus, one of skill in the art would not be motivated to modify Roberts in view of Gerpheide to arrive at the presently claimed invention because the nonabsorptive printed circuit boards of Gerpheide would render the electrodes of Roberts unsatisfactory for their intended purpose. Indeed, Gerpheide explicitly teaches away from Roberts and so one of skill in the art would not be motivated to modify Roberts in view of Gerpheide. Applicants therefore request that the Examiner withdraw the rejection.

Over Sigal in view of Meade, Roberts and Kayyem

Claims 23 and 25 are rejected under 35 USC 103(a) as allegedly being unpatentable over Sigal in view of Meade, Roberts and US Patent 6,096,273 to Kayyem et al.

35 USC 103(c)(1) states that

> Subject matter developed by another person, which qualifies as prior art only under one or more of subsections (e), (f), and (g) of section 102 of this title, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the claimed invention was made, owned by the same person or subject to an obligation of assignment to the same person.

According to 35 USC 103(c)(1), the '273 Patent cannot be used as a reference for a 103(a) rejection.

The '273 Patent does not qualify as a reference under 35 USC 102(a) or (b). If the publication or issue date of a reference is more than 1 year prior to the effective filing date of the application, the reference may be used as a basis for a rejection under 35 USC 102(b). MPEP 706.02(a)(II)(A). For 35 USC 102(a) to apply, the reference must have a publication date earlier in time than the effective filing date of the application. MPEP 706.02(a)(II)(C). The '273 Patent was first published on August 1, 2002. The earliest priority claim of the instant application is to Application No. 60/105,875, filed on October 27, 1998. Since the '273 Patent was published after the effective filing date of the instant application, it cannot be used as a reference under either 35 USC 102(a) or 102(b).

The present application 10/016,416 and US Patent 6,096,273 were, at the time the invention of 10/016,416 was made, owned by Clinical Micro Sensors, Inc.

Assignment of US Patent 6,096,273 to Clinical Micro Sensors, Inc., can be found at reel/frame 008406/0741, recorded March 17, 1997. Assignment of the present application to Clinical Micro Sensors, Inc., can be found at reel/frame 010625/0568, recorded March 20, 2000.

In view of the above statement of common ownership as well as the referenced assignments, US Patent 6,096,273 is not available as a basis of rejection of claims 23 and 25 under 35 USC 103(a). See MPEP 706.02(l)(2)(II). Applicants request withdrawal of the rejection.

CONCLUSION

Applicants believe the claims are in a condition for allowance. Early notification thereof is respectfully requested. The Examiner is invited to call the undersigned at 415.442.1000 to resolve any questions. Although Applicants do not believe any additional fees are required, the Commissioner is authorized to charge any additional fees that may be required or to credit any overpayment to Deposit Account No. 50-0310 (Docket No. 067456-5020-US01).

Respectfully submitted,

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CHAPTER
3

Flexible Circuit Materials

INTRODUCTION

A wide variety of dielectric and conductive materials has been employed in the fabrication of flexible circuits since their invention. One of the earliest descriptions of what could be called a flex circuit can be found in a patent that referred to a construction consisting of flat metal conductors on paraffin-coated paper. Another conceptual substrate was the linen-paper construction with patterned circuits of graphite-loaded gum adhesive that Edison described to his then assistant Frank Sprague (later of Sprague Electric fame).

It was one of many prescient moments for Edison, for it turns out that he was not far from future marks in his thinking. Decades later, one of the types of substrates used for flex circuits was actually based on a paper made from high-temperature aramid fibers, and polymer thick film inks used in PTF flex circuits and membrane switches are substantially the same as what Edison described early in the last century.

While many different materials have been tried and used over time, only a few are in broad use today. This chapter will examine those materials, along with some new choices to help guide the reader to the proper choice for his or her application. First, however, it is worth reviewing what is, in general, desirable from a flexible circuit base material.

DESIRABLE CHARACTERISTICS FOR FLEXIBLE CIRCUIT LAMINATES

While there is no ideal flexible circuit laminate available today, a number of criteria can be used to define the desirable properties of such a laminate. Those properties encompass a broad spectrum of needs that would enable the material to meet all of the demands that might be placed on a finished flexible circuit. Although no known material can meet all of the often conflicting requirements that the manufacturer and user might have, it is, nevertheless, of some value to have a mental picture of an ideal product as a means of keeping in mind what trade-offs one may be required to make when selecting an appropriate substrate for a product or application.

Dimensional Stability

The ideal flexible laminate should be extremely stable dimensionally. Shrinkage or expansion of a flex circuit base material during processing is a concern for both manufacturer and user as it can affect both the fabrication of the circuit and its assembly. It is especially frustrating when dimensional change is not predictable.

A number of steps can be taken to combat the effects of dimensionally non-stable materials (discussed in the chapters on design and manufacturing), but not having to resort to such practices is a definite advantage.

Thermal resistance

Because most electronic assemblers use elevated temperature processes such as reflow soldering for component assembly, it is highly desirable that the flex circuit material chosen for use in manufacture should be able to withstand normal assembly process temperatures reliably without distortion. With the well-meaning but scientifically ill-advised and unwarranted move to lead-free soldering in Europe mandated by legislation, there will be added pressure relative to thermal resistance performance.

Tear resistance

As many flex circuit constructions are thin and unreinforced, they are vulnerable to tearing. Thus, a base material for use in flex circuit manufacture should be highly resistant to any tearing.

Electrical properties

The importance of electrical properties of materials has risen and will continue to rise with the increase in signal speed. Preferred materials for flexible circuit applications should have electrical properties tailored to the needs of the design. With high-data singling speeds (greater than 100 MHz) now becoming more and more common, the material's dielectric constant and loss tangent will, ideally, be low. In addition, high insulation resistance is a desirable property for various high-voltage applications. An ideal material would be an electrical chameleon, meeting whatever electrical requirements were present—but that is a dream and not a likely prospect for the future from any known source.

Flexibility

An obvious property requirement, flexibility is often a critical matter. Depending on application, flexible circuits can be exposed to extremes of temperature, from cookstove hot to cryogenic cold. Thus, flexibility over a wide range of temperatures is essential. Of particular importance is flexibility at low temperatures, where most materials tend to become brittle.

Low moisture absorption

Moisture absorption is definitely not desirable for any flexible substrate. Moisture can negatively impact both the manufacturing process (by causing delamination, in process or in assembly) and the performance of the finished product (by altering the material's dielectric constant and increasing signal loss).

Chemical resistance

Depending on the application, a flex circuit material's ability to resist a range of chemicals is important to both the manufacturer and the end user. The many different corrosive chemistries used in flex circuit fabrication cause the manufacturer to be concerned as to how well the material will stand up to processing. The material must be compatible with a wide range of process chemistries and common solvents used in assembly and cleaning processes.

Lot to lot consistency

Variation is the bane of manufacturing, so product consistency is vital to good process control. While the demands of Six-Sigma quality targets may never be truly obtained in manufacture, extreme consistency of all material properties—including physical, mechanical and electrical—is key. Consistency will provide assurance that the product will perform well both in manufacturing and in the field.

Multiple sources

A great concern of any manufacturer is a situation in which only a single source is available for a product. The vulnerability of both the manufacturer and the customer can, unfortunately, preempt the use of a single-source material, which may otherwise have excellent properties. In most cases, existence of a second source capable of producing an equivalent product is a prerequisite in making a material choice.

Low cost

The pursuit of low-cost solutions is a universal activity in electronics. It is inevitable that there will be a never-ending push to seek lower prices for the material so that both manufacturer and user might enjoy slightly better profit margins. It is, however, important to bear in mind that the real value of a product is best measured in terms of how it impacts total cost of manufacture and the finished product, not in terms of how much it costs to get the material in the door.

With these desirable material attributes fresh in mind, it is possible to review the basic elements of flex circuit materials and some of the typical substructures of flex circuit construction and to understand where the limitations lie, relative to meeting the full complement of objectives.